Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-151-RC2, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Microwave Radar/radiometer for Arctic Clouds MiRAC: First insights from the ACLOUD campaign" *by* Mario Mech et al.

Anonymous Referee #2

Received and published: 7 June 2019

The study titled "Microwave Radar/radiometer for Arctic Clouds MiRAC: First insights-from the ACLOUD campaign" by Mario Mech et al. describes the deployment of a combined FMCW radar – microwave radiometer (MWR) platform onboard a research aircraft to study Arctic clouds.

This paper is divided into two parts: The first part (Section 2+3) is composed of the detailed description of aircraft-installation of the radar-MWR-instrument (named MiRAC) as well as the data processing to derive quality-controlled geo-referenced vertical profile observations. The second part (Section 4+5) focuses on measurements obtained during the ACLOUD field campaign conducted around Svalbard in May/June 2017 and

includes a case-study comparison with CloudSat observations.

The first part of Section 2 describes the FMCW radar system itself, the modifications of the ground-based version to the airborne system (basically, reduction of antenna size to fit into the aircraft at the expense of 6dB sensitivity and a wider half power beam width) and gives valuable information regarding issues arising during airborne downward-looking deployment of an FMCW radar and how they can be mitigated (off-nadir pointing by 25°) to reduce the ground echo influence. The FMCW radar principle is briefly illustrated and concludes with saying that this study focuses on the analysis of the equivalent radar reflectivity factor although "de-aliasing techniques to unfold Doppler velocity can be applied". - The reader is thus left wondering why this has not been done. (?) The capabilities of the FMCW radar allowing for different vertical range resolutions in different chirps are demonstrated for three different chirp programs, however only the characteristics of the first chirp program are discussed. It would be desirable to contrasts the pros and cons of all three used chirp programs.

The description of the passive MWR channels (MiRAC-P) is very technical and even includes a block diagram of the components. – Is this done in such a way because it is a first-time deployment of a novel instrument? If so, please state that clearly.

In Section 3 the different data processing steps are explained in a detailed way. In the radar signal, mirror images are removed and a speckle filter is applied. The description of the filter (p.10 lines 14-26) is sometimes a bit difficult to follow and could benefit from a re-read and some modifications to improve clarity. The multi-step coordinate transformation to convert from range to altitude is described in a straight-forward way and supported by the appendix. One quick question though: On p.12 line 3 it is mentioned that the sensor location is only known within +-0.5m. – This seems like a pretty large uncertainty. – What are the reasons for it?

In Section 4 a roughly 30min CloudSat overpass case study over different sea ice conditions is analyzed and the advantages of the lower blind zone and higher spatio-

temporal resolution of MiRAC is emphazised. The comparison also extends to comparing the brightness temperatures (TB) of the MiRAC-P to the AMSR2-TB-related sea ice concentration product highlighting the ability of MiRAC-P to detect small-scale features like broken sea ice which is not possible by the 6.25 km AMSR2 sea ice product resolution. This comparison is not mentioned in the abstract and should be added there.

Section 5 describes cloud statistics from 19 research flights during ACLOUD. This section can be improved by giving more reasons for surface-type (ice/open ocean) related differences in cloud altitude, observed number of cloud layers, cloud depth, and cloud reflectivities. The CFAD reflectivity plot (Fig 10) has another interesting feature: clouds over ocean exhibit a peak at 0.5-1km at very low reflectivities of below -20 dBz. – What's the explanation? Alternatively, Section 5 can be omitted since the paper has a good story line fitting AMT context which can finish after Section 4. Multiple previous ground-based remote-sensing based studies showing frequent occurrence of low-level Arctic clouds - as done in Section 5 - motivating the need of sensors being able to detect such low clouds already exist. I would suggest the manuscript to be published after minor revision addressing the above-and below points.

Minor comments

p.1 line 15: While it is important to fill the measurement gap of the CloudSat blind zone below 1.5km the phrase "MiRAC is able to fill the gap" seems a bit too strong since MiRAC is an aircraft-mounted instrument and thus limited in time and space and providing several tens of hours of observations during one field experiment instead of continuous coverage. . .please rephrase. p.2 line 3: Osborne et al. - publication year is missing p.2 line 6: Barrow is now called Utqiagvik p.2 line 7: add Summit, Greenland: https://esrl.noaa.gov/psd/arctic/observatories/summit/ p.2 line 13: missing citation p.2 line 22: Indicate how long the first airborne field experiments in the Arctic date back to p.2 line 25: ". . .Arctic nimbo stratus ice cloud observed during POLARCAT. . ." p.3 line 12: a "Second" without a "first" earlier on. . . p.3 lines 16-19: refer to the photograph/

of the placement of MiRAC-A and -P on the Polar 5 already here (Fig3) p.4 line 26: You mention the first chirp program is used for the first research flight – in Table 1 it is however stated that chirp setting "I" is used for RF04 and RF05. p.4 line 29: It sounds contradictory to state that based on the good performance of the chirp program "I" you modified it twice. . .why modify if performing well? p.4 lines 33-35: Be more precise how you identify the receiver saturation. The sentence "b. . .ackscatter of hydrometeors or the surface echoes are strong enough to shift Z_min over the full profile." is not clear – please clarify. p.8 line 16: add "during ACLOUD field experiment" p.9 line 18: replace "beyond" with "below" p.10 line 3: Second part of the flight is in the marginal sea ice zone. . .and the first part? p.11 line 11: "at" the expense p.15 line 13: add "AMSR2" before sea ice product p.15 line 29: 25m vertical resolution only refer to chirp program I in Table 1, correct? p.17: the "sea ice concentration of Bremen"? – There is sea ice in Bremen? ;) – Please correct. p.17 line 10: The sentence regarding "the number of measurements above sea ice "is increased" with respect to number of measurements above open ocean" is unclear. Do you mean "is higher"? p.17 line 12: Deriving a cloud depth over sea ice lower than 800m from Fig 9 seems a bit arbitrary. . .

Figures

Please check Figure quality (Fig6+7 have low resolution) and make sure all figures have proper axis labels with a variable and units (Fig1, Fig4, Fig5).

Fig1: Why is there an extra colorbar in the middle panel?

Fig 7: Add the Channel frequencies in the lower three panels to increase comparability between figure and description in the text.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-151, 2019.